CORRESPONDENCE

Efficacy of mumps vaccine

To the editor: The article by Lewis and colleagues concerning an epidemic of mumps in a partially immune population (*Can Med Assoc J* 121: 751, 1979) presents an incorrect interpretation of the efficacy of mumps vaccine. The low attack rate in vaccinated children does not in itself reflect protective efficacy, and therefore should be compared with the attack rate in the unvaccinated children. The standard formula for the calculation of vaccine efficacy in epidemics is as follows:[1]

$$\text{Efficacy } (\%) = \frac{u-v}{u} \times 100,$$

where u = the attack rate in unvaccinated persons and v = the attack rate in vaccinated persons.

In the epidemic described by Lewis and colleagues the attack rate was 5.5% among the vaccinated children and 21.7% among the unvaccinated children. According to this formula the efficacy of the mumps vaccine was 74.7%.

In view of the seroconversion rate of 95% achieved in an earlier study,[2] a protective efficacy of only 74.7% should be cause for concern.

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References

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2. HILLEMAN MR, WEIBEL RE, BUYNAK EB, et al: Live, attenuated mumps-vaccine. 4. Protective efficacy as measured in a field evaluation. *N Engl J Med* 276: 252, 1967

To the editor: One way of measuring vaccine efficacy is to compare attack rates among unvaccinated and vaccinated persons using the formula:[1]

$$\text{Efficacy } (\%) = \frac{u-v}{u} \times 100,$$

where u = the attack rate in unvaccinated persons and v = the attack rate in vaccinated persons.

When this formula is used with the figures in Lewis and colleagues' article the vaccine efficacy is found to be 74.7%. This is a better way of measuring the effectiveness of a vaccine than determining if there is a statistical difference in attack rates. With the use of the formula the observation by Hilleman and colleagues[1] that seroconversion did not occur in 5% of children and the fact that 5.5% of the immunized children in Lewis and colleagues' study acquired mumps will not be related. If the attack rate was only 21.7% in the unimmunized children why would it be postulated to be 100% in those who were immunized?

In Lewis and colleagues' study the efficacy of the mumps vaccine was very similar to the efficacy of measles vaccine found in Greenwood, Ont. (73%)[2] and in Newfoundland (76%).[3] A vaccine efficacy of 75% indicates that more people in the population will be susceptible to the disease than if the vaccine is 95% effective. The

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implications for control are that if virus transmission is not stopped with 75% immunity in a population it will be difficult to control either measles or mumps.

More studies such as that of Lewis and colleagues are urgently needed. These workers are to be congratulated for investigating a problem that many physicians do not recognize as such.

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2. RAULS WE, RAULS ML, CHERNESKY MA: Analysis of a measles epidemic; possible role of vaccine failures. *Can Med Assoc J* 113: 941, 1975
3. Measles outbreak — Newfoundland: further observations on vaccine effectiveness. *Can Dis Wkly Rep* 3: 134, 1977

[*Efficacy was recently defined in the Journal (121: 1203, 1979) as "the attribute of an intervention or maneuver that results in more good than harm to those who accept and comply". Effectiveness was defined as "the attribute of an intervention or maneuver that results in more good than harm to those to whom it is offered". The formula of the Center for Disease Control (CDC), Atlanta, Georgia implies that the efficacy of a vaccine can be judged by its effect in reducing the probability of disease in a vaccinated population standardized to the probability of disease in an unvaccinated population. It does not refer to the proportion of susceptible and immunized individuals in the population. Effectiveness depends on the actual proportions of persons immunized and at risk during a given outbreak — that is, a highly efficacious vaccine would not be effective if few individuals were vaccinated.*

Lewis and colleagues did not use the word efficacy in the manner defined by the CDC — they were referring only to the attack rate in vaccinated persons, not the attack rate in unvaccinated persons minus that in vaccinated persons divided by the attack rate in vaccinated persons. If the number of cases of mumps among the unimmunized children (76) were referred to the base of all the unvaccinated children (568) instead of only those unvaccinated who had no previous history of mumps (350) the attack rate among the unvaccinated would have dropped to 13.0% and the efficacy to 57.7%. This demonstrates clearly that according to the CDC formula the efficacy of a vaccine of a given biologic activity decreases as the attack rate among unvaccinated persons decreases. Furthermore, the lower the attack rate among unvaccinated persons the more efficacious will be an improved vaccine. If a vaccine were developed to produce a 98% rate of seroconversion instead of the 95.5% observed in Lewis and colleagues' study, the efficacy of the examples cited above would rise from 74.7% to 90.8% (a 22% increase) and from 60.4% to 85.6% (a 42% increase). Even so, it is obvious that, in terms of effectiveness, as long as the present rates of vaccination acceptance apply few additional people would be protected by this superpotent vaccine. In the presumably typical situation described by Lewis and colleagues efficacy will depend mostly on the attack rate in unvaccinated persons, and does not seem to be as meaningful a concept as effectiveness. On the basis of the observed numbers and the attack rates in vaccinated and unvaccinated persons it can be calculated that the mumps vaccine prevented 32 cases of mumps among the 145 vaccinated children and would have prevented all but 14 of the 76 cases among the 350 children susceptible to the disease. If all the vaccinated children are considered susceptible the administration of vaccine to all 495 persons at risk would have prevented all but 22 cases, whereas in reality there were 86 cases. Thus, the immunization program in the Hamilton area does not seem to be nearly as effective as it is efficacious.

I thank Dr. R. Gold, whose editorial accompanied the article by Lewis and colleagues, for pointing out an error in their Table II. The numerators include all children with mumps while the denominators exclude the 145 vaccinated children, of whom 8 had mumps. However, I do not believe the error will substantially affect the strong relationships in the table. — P.P. Morgan, MD, DPH, DEpid, associate scientific editor, CMAJ.]

Autopsy of an Egyptian mummy (Nakht — ROM I)

To the editor: Two years ago the Journal carried several papers describing an elaborate autopsy on the Egyptian mummy of Nakht (ROM I), a boy-weaver who had supposedly lived about 1200 BC (*Can Med Assoc J* 117: 462, 1977). An interesting article on the archeologic background was written by Dr. N.B. Millet, curator of the Egyptian department of the Royal Ontario Museum. He claimed that there was "unusually clear evidence of the date" because the boy had undoubtedly lived in the reign of King Setnakht, the immediate predecessor of the great pharaoh Ramesses III. According to Dr. Millet Ramesses III had ascended the throne about 1198 BC.

I subsequently wrote a long letter (*Can Med Assoc J* 118: 20, 1978) pointing out that orthodox Egyptian chronology, although, indeed, the accepted basis for the chronologies of a vast area of the Middle East, had become the subject of controversy. Dr. Immanuel Velikovsky, a retired psychiatrist, had produced a revised Egyptian chronology that indicated that the accepted dates for the New Kingdom were too old by roughly 500 to 800 years. It so happened that the widest disparity between his chronology and the orthodox chronology occurred at the time of Ramesses III. Dr. Velikovsky believes that Ramesses III began his reign not in 1198 BC but in 379 BC — fully 800 years later. In my letter I suggested that radiocarbon dating of the mummy would make an ideal test for valid chronology, particularly as this mummy's provenance could hardly have been better attested. I offered to wager the cost of the carbon-14 test that